

Articles

Carotid Endarterectomy for Prevention of Stroke

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Carotid endarterectomy, a frequently performed operation, has been used as a strategy for preventing stroke in patients with carotid bifurcation disease. The safety and efficacy of the operation were recently challenged by a number of sources. Three major responses to this challenge were to retrospectively review the natural history of carotid bifurcation disease compared with the immediate and long-term results of carotid endarterectomy, to initiate 6 prospective randomized trials to determine the efficacy of carotid endarterectomy for a variety of indications, and to develop appropriateness initiatives and guidelines for using this surgical procedure by organizations concerned with health care policy. I review the current status of these 3 areas of endeavor. In those areas where studies are complete, carotid endarterectomy has been shown to be highly effective in reducing stroke risk. Risk reduction has ranged from 66% to 80% compared with medical management. Based on these sources and findings, I present a list of indications for the operation for surgeons who are able to do the operation safely and within the guidelines established by the Stroke Council of the American Heart Association.

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Stroke continues to be the third leading cause of death in the United States each year. It also represents a major cause of morbidity and contributes heavily to health care costs. The current annual incidence of stroke is about 195 per 100,000 people, and the incidence increases with increasing age. Thus, in men aged 55 to 64, the incidence is 300 per 100,000 and increases dramatically in the age group 75 to 84, with an incidence of 1,440 per 100,000.¹ Of the patients who survive the initial stroke, about two thirds will be disabled to some degree. Half of the survivors will live for about five years, and a third of the survivors require prolonged inpatient rehabilitation.²

The recognition of the correlation between carotid bifurcation disease and ischemic hemispheric stroke from a thromboembolic event was long in coming. Since the first reported operation on the carotid bifurcation in 1954, however, there has been a rapid rise in the use of carotid endarterectomy as a strategy for stroke prevention. The annual number of operations rose from 17,000 in 1971 to about 100,000 in 1984.³ The enthusiasm for the surgical procedure continued to grow until 1984 when a pivotal issue of the journal *Stroke* appeared (volume 15, number 6) that contained a collection of articles questioning the efficacy and use of carotid endarterectomy.⁴⁻⁷ This collection was prefaced by an editorial entitled "Carotid Endarterectomy—An Expression of Concern," written by three eminent neurologists from Canada, the United States, and

the United Kingdom.⁸ This challenge attracted much attention by scientists and the lay media, causing sufficient doubt to be cast on the efficacy of this surgical procedure and resulting in a major cutback in its use over the next few years. In addition, and as a consequence of this heated debate, three major endeavors were initiated. These included a series of reports documenting the natural history of carotid bifurcation disease compared with retrospective reviews of surgical series, looking at both initial and long-term outcomes; a series of prospective randomized trials that were begun or further supported; and various interest groups getting together to develop appropriateness initiatives or practice guidelines for the use of carotid endarterectomy. In this report I shall discuss and analyze the results of these three major courses of action and shall summarize the current indications for carotid endarterectomy based on the best available data, including prospective randomized trials and the analysis of results by expert panels.*

Natural History Studies and Retrospective Reviews

The early reported series of carotid endarterectomy dealt primarily with the surgical morbidity and mortality associated with the operation. Over time, the incidence of death within 30 days and of perioperative stroke contin-

*See also the editorial "Carotid Endarterectomy—The Big Picture," by J. F. Toole, MD, on pages 90-91 of this issue.

ABBREVIATIONS USED IN TEXT

AMCC = Academic Medical Center Consortium
 CASANOVA = Carotid Artery Surgery Asymptomatic
 Narrowing Operation Versus Aspirin
 NASCET = North American Symptomatic Carotid
 Endarterectomy Trial
 TIA = transient ischemic attack
 VA = [Department of] Veterans Affairs

ued to decline in centers of excellence. Community-based studies showed an alarming incidence of perioperative death and stroke, however, when the overall experience was surveyed in contrast to that of single institutions.^{6,9} These findings were taken into consideration by those who were challenging the efficacy of carotid endarterectomy and its widespread use. There were little data available at that time to determine the long-term results in patients who had undergone carotid endarterectomy. Therefore, many institutions began a concerted effort to look at not only the perioperative results but also the late consequences in patients treated by carotid endarterectomy with regard to the subsequent incidence of stroke as well as survival. Obviously, if there was shortened survival among patients with carotid bifurcation disease, the widespread application of carotid endarterectomy as a preventive procedure may well not have an important effect for the population at risk. Finally, although there were early natural history studies of the incidence of stroke in various patient subgroups, the subgroup analysis was poorly defined. For example, many articles dealt with the incidence of stroke associated with transient ischemic attacks (TIAs). Yet, the character of the TIAs was inevitably heterogeneous, and the nature of the underlying lesion with respect to the percentage of stenosis or plaque composition was not defined.

Retrospective reviews primarily divided patient groups by their symptomatic status and compared results in patients without treatment, in those with the use of antiplatelet drugs, and in those with carotid endarterectomy.

Territorial Transient Cerebral Ischemia

Natural history studies suggest that patients with monocular or hemispheric TIAs have a risk of stroke that ranges from 10% to 30% within one year of the beginning of symptoms and continues at the rate of 6% per year thereafter, yielding an overall stroke risk of 35% to 50% within five years of the onset of symptoms.¹⁰⁻¹⁵ The use of antiplatelet drugs, particularly aspirin, has been extensively studied. Aspirin therapy will lower the risk of stroke in patients with hemispheric and monocular TIAs, but the benefit is small. Meta-analysis of all the aspirin trials suggests that the overall benefit of aspirin use is to lower the stroke rate by about 15%.¹⁶ This effectively means that if the incidence of stroke in a particular subgroup was 10% in one year, a 15% risk reduction would lower it to 8.5%.

Carotid endarterectomy for patients having hemispheric or monocular TIAs will carry a variable operative risk ranging from 3% to as high as 18% for neurologic

morbidity and mortality.^{9,17-23} The American Heart Association has recommended that for carotid endarterectomy to be effective in patients who have had TIAs, the combined neurologic morbidity and mortality following the operation must not exceed 5%.²⁴ Many centers of excellence are currently achieving rates considerably less than this. After successful carotid endarterectomy, the annual stroke rate drops to a range of 1% to 2%.^{20,25-30} This is in marked contrast to that in patients who receive medical management alone and represents a 67% stroke risk reduction.

Previous Stroke With Minimal Residual Deficit

Patients who have had a previous hemispheric stroke remain at risk for a subsequent stroke at the rate of 5% to 20% per year, with the average five-year recurrence rate being 50%.³¹⁻³⁴ Carotid endarterectomy for patients who have had a previous stroke and have made a good recovery carries a higher risk than that for patients who have not yet had a stroke. The Stroke Council of the American Heart Association has recommended that the operative risk for patients who have had a previous stroke and have made a good recovery should not exceed 7%.²⁴ Once again, centers of excellence have been able to achieve morbidity and mortality rates of less than 5%, and many are reporting rates of 3%. After successful carotid endarterectomy, the recurrent stroke rate is reduced to an event rate of 2% per year.^{20,28,29,35-37} In contrast, patients who are treated medically have recurrent stroke rates ranging from 9% to 16% per year.³¹⁻³⁴ Therefore, at the end of five years, an operation appears to reduce the stroke risk by at least 66% compared with medical management alone.

Asymptomatic Carotid Stenosis

Patients who have asymptomatic stenoses with 75% or more reduction in the diameter of the carotid bulb have been shown to have neurologic event rates (TIA and stroke) of 18% in one year.³⁸ The event rate for stroke alone is about 5% in one series but may be lower. Another series has shown that the risk of combined events of TIA, stroke, or occlusion of the internal carotid artery in patients with more than 80% diameter-reducing stenosis is 46% within 12 months of diagnosis.³⁹ Internal carotid occlusion, even though it may occur without symptoms initially, carries a risk of subsequent stroke of 5% to 10% per year.^{40,41} This is of concern because once the internal carotid artery is occluded, the opportunity to restore or preserve patency has been lost because the internal carotid artery is an unbranched vessel and thrombus will propagate intracranially.

Carotid endarterectomy for patients with asymptomatic stenoses carries the lowest risk of any category. The Stroke Council of the American Heart Association recommends that this operation be performed with a risk of less than 3%.²⁴ Our recently reported series carried a combined neurologic morbidity and mortality of 1.4%.⁴² Following successful carotid endarterectomy, the risk of subsequent stroke in the distribution of the treated artery

averages 0.3% per year in cumulative series.⁴³⁻⁴⁵ The incidence of stroke in our series was 0% in the distribution of the surgically treated artery with a mean follow-up of 54 months.⁴²

Miscellaneous Categories

A number of other subsets of patients include those who present with global ischemic symptoms, acute stroke, and evolving stroke. The numbers of these patients are small, and the reports at best are anecdotal. Therefore, decisions of whether or not to offer the operation for this category of patient must be tailored for each patient and cannot, at the present time, be definitively answered from the available literature.

Prospective Randomized Trials

Although retrospective data appear to confirm the efficacy of carotid endarterectomy when compared with medical management alone, there are many criticisms and potential pitfalls associated with retrospective analyses and historic controls. For this reason, prospective randomized trials were initiated to evaluate the effect of adding carotid endarterectomy to medical management and risk factor control to determine definitively whether or not carotid endarterectomy lowered the stroke risk in specific subsets of patients with atherosclerotic disease of the carotid bifurcation. There are currently six prospective randomized trials in various stages of progress or completion. Three of these examine asymptomatic patients with hemodynamically notable stenoses of the carotid bifurcation,⁴⁶⁻⁴⁹ and the other three examine patients with symptomatic disease.⁵⁰⁻⁵² It is anticipated that when these studies are complete and the data are analyzed, definitive answers will be established with regard to the efficacy of carotid endarterectomy and hence the indication for its application.

Asymptomatic Patients

Veterans Affairs (VA) Cooperative Study. The VA initiated the first of the prospective randomized trials for asymptomatic patients. This study was begun in 1980 and involved 11 VA Medical Centers.^{46,47} Patients with 50% or greater diameter-reducing stenoses and with no symptoms in the distribution of the study artery were prospectively randomly allocated to one of two treatment groups; the control group received aspirin antiplatelet therapy and risk factor reduction, and the experimental group received aspirin antiplatelet therapy, risk factor reduction, and carotid endarterectomy. A total of 444 patients were entered into the study and were observed for five to seven years. The study was designed to test the hypothesis that carotid endarterectomy plus aspirin antiplatelet therapy would be more effective than antiplatelet therapy alone in reducing the incidence of neurologic events, including TIA and stroke. The results of the study clearly supported the hypothesis and demonstrated that the combined incidence of ipsilateral neurologic events in the surgical group at the end of follow-up was 8.0%, in contrast to an event rate of 20.6% in the medical group ($P < .001$). Be-

cause the study was designed to look at the end points of both TIA and stroke, the sample size was adjusted for the combined end points and was not large enough to provide statistical power for showing a difference in the analysis of stroke alone. Nonetheless, the ipsilateral stroke rate in the surgical group was 4.7% compared with 9.4% in the medical group ($P < .06$). When perioperative mortality was added to stroke morbidity, the difference between the two groups with respect to stroke failed to reach statistical significance. As a consequence, the results of this trial will continue to be controversial. Those who favor the use of carotid endarterectomy in asymptomatic patients as an important method of prophylaxis will cite the positive findings of the trial, and those who are opposed to its use will emphasize the lack of definitive data when analyzing stroke alone as an end point.

Carotid Artery Surgery Asymptomatic Narrowing Operation Versus Aspirin (CASANOVA). The CASANOVA study, a European trial, was designed to determine the efficacy of the operation on asymptomatic patients.⁴⁹ A total of 410 patients with stenoses ranging from 50% to less than 90% were randomly allocated to one of two groups. The experimental group received carotid endarterectomy plus antiplatelet drugs ($n = 206$), and the control group was to have received antiplatelet drugs alone ($n = 204$). In a careful review of the report, several flaws of design and statistical analysis were revealed that seriously compromise the value of the study. First, patients with stenoses of 90% or greater, perhaps the highest risk group, were excluded from entry into the study and were operated on preferentially. Therefore, the opportunity to evaluate this group and to add them to the analysis was lost. In addition, there were a number of problems associated with the control group. A large percentage of the patients in the control group actually received an operation, but in an "intent-to-treat" design analysis, the result was not attributed to an operation but to medical management. Patients in the control group receiving an operation included those with bilateral carotid stenoses in whom the stenosis of greater compromise was treated with carotid endarterectomy and the lesser lesion was observed. Furthermore, if a patient was allocated to medical management and during the course of study the lesion progressed to a stenosis of 90% or greater, the patient was switched to the group having carotid endarterectomy. If bilateral carotid stenosis developed in a patient in the control group during the course of follow-up, carotid endarterectomy was done on one lesion if it exceeded a 50% in diameter reduction. Finally, patients who were allocated to the medical group were switched to the group having carotid endarterectomy if symptoms of transient cerebral ischemia developed. While all of these indications for an operation would appear to be reasonable, none of the events for which a patient allocated to the medical group was converted to surgical treatment were charged as an end point or considered a failure of therapy for purposes of statistical analysis. The result was that of the 206 who were randomly assigned to medical treatment, 118 (57%) actually underwent carotid endarterectomy but were analyzed as if

they were treated with medical management alone. Not surprisingly, there were no statistically significant differences between the surgical group and the group receiving "medical management." The authors of the study erroneously concluded that carotid endarterectomy was not efficacious in asymptomatic patients in preventing stroke. A more appropriate conclusion might have been that selective carotid endarterectomy offered to patients with stenoses in excess of 90%, patients with bilateral carotid stenoses, or patients in whom symptoms developed was as effective as the routine application of carotid endarterectomy in all patients.

Asymptomatic Carotid Artery Stenosis Study. The Asymptomatic Carotid Artery Stenosis Study is a prospective randomized trial sponsored by the National Institutes of Health and involving 34 centers in North America.⁴⁸ When completed, it will be the largest and possibly the most definitive trial of carotid endarterectomy in patients with asymptomatic carotid stenosis. The study is testing the hypothesis that carotid endarterectomy, when added to aspirin therapy plus risk factor modification, will reduce the incidence of TIA and cerebral infarction in patients with hemodynamically notable carotid stenosis when compared with patients treated with aspirin plus risk factor modification alone. The design of the trial includes randomly allocating 1,500 patients into the two treatment arms. A five-year follow-up will be included.

The randomizing of patients began in the spring of 1988. To date, about 1,300 patients have been randomly allocated, and it is anticipated that the allocation will be completed in the winter of 1993. The hope is that with this large sample size, a definitive answer will be forthcoming with respect not only to the combined end points of TIA and stroke but also to stroke alone.

Symptomatic Patients

North American Symptomatic Carotid Endarterectomy Trial (NASCET). The NASCET trial, a large, ambitious, randomized study involving several centers in the United States and Canada, was intended to enroll 3,000 patients who were having TIAs or stroke within 120 days of the event, provided that they had angiographic evidence of an appropriate carotid bulb stenosis ranging from 30% to 99%. In the randomizing process, patients were stratified into two groups based on the degree of stenosis: 30% to 69% and 70% to 99%. These were randomly allocated to a control group that received the best available medical management and an experimental group that included the best available medical management plus carotid endarterectomy.

In February 1991 a "clinical alert" was issued by the National Institutes of Health that patients who were in the 70%- to 99%-stenosis group did dramatically better with carotid endarterectomy than those who were treated with the best medical management alone. Therefore, this portion of the study was stopped, and the rest of the patients who were in the control group were advised to undergo carotid endarterectomy. When compared with medical

therapy, surgical therapy reduced the risk of stroke by 71% and the risk of death by 58%. The conclusion was that carotid endarterectomy was highly beneficial for symptomatic patients with high-grade stenoses. At the time of that review, a dramatic difference did not exist for the subgroup of patients with stenoses in the range of 30% to 69%, and that portion of the study continues to this date.⁵⁰

European Carotid Surgery Trial. The European Carotid Surgery Trial, involving several centers, randomly allocated 2,518 patients over a ten-year period.⁵¹ The study patients were stratified into three groups depending on the degree of stenosis: mild (0% to 29%), moderate (30% to 69%), and severe (70% to 99%). At about the same time as the clinical alert for the NASCET trial was announced, the European study reported similar results in the high-grade stenosis category. They also noted that patients with mild lesions appeared to derive no benefit from the operation compared with medical management alone. They, like the NASCET investigators, are continuing to randomly allocate patients with moderate stenoses in the range of 30% to 69%. In patients with severe stenosis, surgical therapy reduced the risk of subsequent ipsilateral stroke by more than 80%.

Veterans Affairs Symptomatic Trial. The VA study of symptomatic patients with high-grade stenoses was at an early stage when the results of the NASCET study and the European trial were reported. Because it would have been unethical to continue to randomly allocate patients to less effective therapy, the study was stopped. The opportunity was then presented to evaluate the results in 189 patients who were randomly allocated to carotid endarterectomy and best medical management (n = 91) and a control group of patients who were treated with best medical management alone (n = 98). After a mean follow-up interval of only 11.9 months, there was a significant benefit to patients who received carotid endarterectomy compared with that to the control group. Thus, the results of this study further corroborate the data presented by the NASCET trial and by the European study. The VA study also added an additional dimension, and that had to do with patients who were having crescendo TIAs. This trial showed that those patients were at particularly high risk of stroke in the control group and did statistically significantly better when treated with carotid endarterectomy.⁵²

Appropriateness Initiatives and Practice Guidelines

Because of the controversial nature of carotid endarterectomy and the conflicting data that had previously been published, several organizations have taken the initiative to review the available data and publish their reports concerning appropriate indications for carotid endarterectomy and practice guidelines. I shall highlight three initiatives and include the Rand-Academic Medical Center Consortium (AMCC) initiative, the publication of a report by the Ad Hoc Committee of the Joint Council of the Society for Vascular Surgery and the North American Chapter of the International Society for Cardiovascular

Surgery, and an ongoing effort by the Office of Quality Assurance by the American Medical Association.

*Rand-Academic Medical Center
Consortium Appropriateness Initiative*

The Rand Corporation, a think tank located in Santa Monica, California, reviews critical issues in many disciplines. Health care is one such discipline, and the utilization of various procedures, including carotid endarterectomy, has been a major focus of this organization. The AMCC consists of a group of ten academic medical centers that work together on areas of mutual interest. In 1990 these two organizations combined efforts to evaluate the appropriateness of the use of several procedures including carotid endarterectomy. The Rand Corporation assumed the task of developing appropriateness and necessity criteria for the use of carotid endarterectomy, and the AMCC assumed the responsibility of using these criteria in a self-audit of the practice patterns in their respective medical centers. Following the audit, key people from each of the academic medical centers were invited to participate in a conference to critique the Rand ratings and to review the results of the combined audit of the hospitals within the AMCC and of their individual hospitals. The objective of this effort was to develop appropriateness criteria, tested in academic medical centers, that could then be made available to professional societies for the development of practice guidelines.

The Rand Corporation works in the following manner. The literature is reviewed, and opinions from local experts and designated members of specific medical specialty societies are solicited. Following this, an initial set of possible indications for carotid endarterectomy is developed. A panel of physicians with specific skills in the area of cerebrovascular disease is selected from nominations by medical specialty societies with interest in cerebrovascular disease.

The final panel included representation from the disciplines of neurology, vascular surgery, neurologic surgery, cardiology, and neuroradiology. Each panel member was given a copy of the literature review and a list of the possible indications for carotid endarterectomy and was asked to make an appropriateness rating for the operation based on a nine-point scale: A score of 9.0 would indicate that the operation was highly appropriate, and a score of 1.0 would indicate that the operation was clearly inappropriate. The initial ratings were performed individually in confidence. The group was then convened, discussions were carried out, and a second set of ratings was obtained. The results were then collated, and a median score in the range of 7 to 9 indicated an appropriate indication for carotid endarterectomy, 4 to 6 designated uncertain appropriateness (or split opinion), and 1 to 3 represented an inappropriate indication for operation. The Rand panel went a step further and carried out a survey of necessity ratings. In this instance, an indication for carotid endarterectomy was not only appropriate but represented the best form of treatment and therefore would be considered necessary. As such, failure to offer carotid end-

arterectomy would be considered inappropriate. The initial results of the literature survey, the appropriateness ratings, and the necessity ratings have been published by the Rand Corporation.⁵³ Subsequent publications from the joint Rand-AMCC effort are forthcoming.

*Recommendations of the Joint Council of the
Society for Vascular Surgery and the
International Society for Cardiovascular Surgery*

The Joint Council of the Society for Vascular Surgery and the International Society for Cardiovascular Surgery identified the need to develop guidelines for applying carotid endarterectomy. An ad hoc committee was convened, and at an initial meeting it was determined that the committee structure should be extended to involve other disciplines. The final committee therefore included three vascular surgeons, two neurologists, and a neurologic surgeon. This group thoroughly searched the literature, concentrating primarily on recent publications that reviewed the natural history of carotid artery disease, the contemporary risks of the operation, and the immediate and long-term results in patients treated with carotid endarterectomy. They also examined the results of prospective randomized trials where data were available. This committee published a report that reviewed the various presenting features of patients with carotid artery disease and commented on the circumstance under which carotid endarterectomy was the best treatment and those conditions that were best managed medically.⁵⁴

American Medical Association Effort

The Office of Quality Assurance of the American Medical Association looked at several surgical procedures and, to address practice guidelines, mounted an effort to reach a consensus concerning their application. A committee was developed consisting of members representing the various specialty organizations that had a specific interest in the procedures being reviewed, including carotid endarterectomy. A subcommittee was asked to address the issue of carotid endarterectomy and did this by reviewing the Rand-AMCC report and comparing it with the Joint Council's publication. This effort is still going on and will include a comparison of ratings and a final suggested list of indications for carotid endarterectomy. The initial review and comparison of the two documents yielded a high degree of concordance concerning indications for carotid endarterectomy (Matchar DB, Huesgen CT, Moore WS, "Indications for Carotid Endarterectomy: A Comparison of Ratings by a Multidisciplinary Expert Panel With Recommendations from the Joint Council of the Society for Vascular Surgery and the International Society for Cardiovascular Surgery [North American Chapter]," unpublished data, March 1993). With the passage of time and the accumulation of data, both retrospective and prospective, the risks, benefits, and hence indications for the application of the operation are apparently becoming better defined and more universally accepted. Because there was excellent concordance between these two efforts, and until the recommendations are actually pub-

TABLE 1.—Current Indications for Carotid Endarterectomy

| Patients | Source of Recommendation | | | |
|---|-----------------------------|------------|----------------|-------------------|
| | Retrospective Data Analysis | Rand Panel | Joint Council* | Randomized Trials |
| Symptomatic | | | | |
| Single focal TIA (>70% stenosis) | Yes | Yes | Yes | Yes |
| Multiple focal TIAs with | | | | |
| >70% Stenosis | Yes | Yes | Yes | Yes |
| >50% Stenosis with ulceration | Yes | Yes | Yes | NA |
| 50% to 69% Stenosis† | Yes | Yes | Yes | NA |
| 30% to 49% Stenosis† | Yes | Yes | Yes | NA |
| <30% Stenosis with or without ulcer† | Yes | Yes | Yes | No |
| Previous stroke (mild), ipsilateral | | | | |
| >70% Stenosis | Yes | Yes | Yes | Yes |
| >50% With large ulcer | Yes | Yes | Yes | NA |
| 30% to 69% with and without ulcer | Yes | Yes | Yes | NA |
| Evolving stroke | | | | |
| >70% Stenosis | Yes | Yes | Yes | NA |
| Global symptoms | | | | |
| >70% Carotid stenosis with uncorrectable vertebrobasilar disease | Yes | Yes | Yes | NA |
| Asymptomatic | | | | |
| >70% Stenosis with contralateral occlusion or high-grade stenosis | Yes | Yes | Yes | NA |
| >70% Unilateral stenosis | Yes | No | Yes | NA |
| Large ulcer with >50% stenosis | Yes | No | NA | NA |

NA = not available, TIA = transient ischemic attack

*Joint Council of the Society for Vascular Surgery and the International Society for Cardiovascular Surgery (North American Chapter).

†Patients on aspirin therapy.

lished, the readers are referred to the specific publications that were compared.^{53,54}

Surgery Quality Control

Carotid endarterectomy is a prophylactic operation to prevent stroke. This is the case for both symptomatic and asymptomatic patients. The effectiveness of the operation will vary inversely with the morbidity and mortality resulting from the operation. Thus, the lower the morbidity and mortality, the better the benefit-to-risk ratio with the operation compared with the natural history of the disease.

There is considerable variation in surgical results reported in the literature. Morbidity and mortality have been reported to range from 1% to 18%.^{9,17-23,42} Recently a committee of the Stroke Council of the American Heart Association has published recommendations with regard to the upper acceptable limits of stroke morbidity and mortality as a function of indications for the operation. These limits should not exceed a combined morbidity and mortality of 3% when operating on patients with asymptomatic lesions, 5% in patients who undergo the operation for TIAs, 7% when the operation is performed for patients with a previous stroke, and 10% when the operation is being done for recurrent carotid stenosis.²⁴

The audit and enforcement of these limits among surgeons in both community and institutional practice should have a major beneficial effect in assuring the best possible result of the operation with minimal morbidity and mortality. The vascular surgery community has made

specific recommendations with regard to training, experience, hospital privileges, and periodic audit of those surgeons wishing to do vascular operations including carotid endarterectomy.⁵⁵⁻⁵⁷

Current Indications for Carotid Endarterectomy

From the previous discussion, it should be apparent that judging the indications for carotid endarterectomy remains fluid because several efforts at evaluation are still in progress. Nonetheless, and based on available data, it is possible to make some firm recommendations at this time. These recommendations will be based on the several units of analysis currently available and are summarized in Table 1. The indications listed in the table are based on the assumption that surgeons who do the operation can do so within the limits of morbidity and mortality set by the Stroke Council of the American Heart Association.²⁴

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